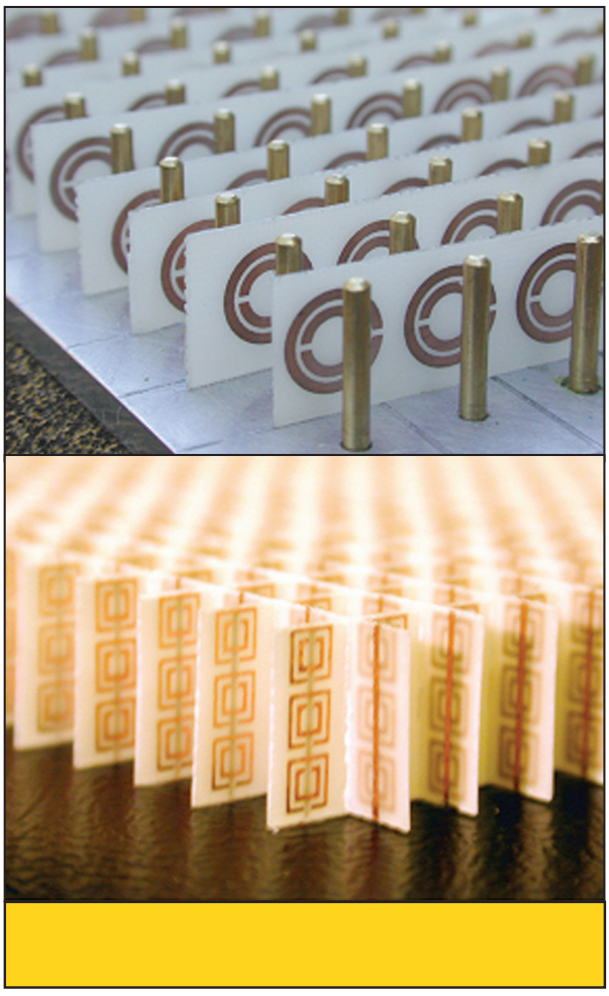
Air Force Research Laboratory | AFRL

Science and Technology for Tomorrow's Aerospace Forces

Success Story

NEW CLASS OF COMPOSITE MATERIALS



A new material could prove useful in improving communication by developing new optical lenses, novel antennas and filters, and other electromagnetic devices. It may even make possible the construction of a "perfect lens," capable of focusing light and other forms of radiation to limits not achievable by normal lenses. These advances would offer significant advantages to many Air Force applications.

Air Force Research Laboratory
Wright-Patterson AFB OH

Accomplishment

Funding from the Physics and Electronics Directorate of the Air Force Office of Scientific Research and the Defense Advanced Research Projects Agency supported a team of physicists from the University of California, San Diego (UCSD), who verified predictions for a new class of composite materials. Last year, researchers produced these composite materials believing they would exhibit behaviors opposite of many fundamental properties commonly associated with composites.

Background

Drs. Richard Shelby, David Smith, and Sheldon Schultz at UCSD tested earlier theoretical predictions of new electromagnetic properties. After building a prototype of their proposed composite from fiberglass and tiny copper wires, the researchers sent microwaves of the same frequency used in police radar guns through the material. The microwaves emerged from the sample with a deflection opposite to that predicted by Snell's law for ordinary materials, thus confirming the predictions.

Snell's law describes the angle of refraction—the angle through which light and other forms of electromagnetic radiation are deflected on entering water, glass, and other ordinary materials. Physicists refer to the parameter that determines the degree of deflection caused by a material as its index of refraction. Normal materials have a "positive" index of refraction, associated with a deflection produced by the slowing of light on entering the material.

When radiation enters the new class of composite materials produced by UCSD researchers, it is bent in the opposite direction, equivalent to exhibiting a "negative" index of refraction. Since no existing composite has this property, the UCSD scientists demonstrated the effect using a metamaterial—a composite material fabricated from repeated elements, specifically engineered to produce the desired electromagnetic behavior.

Engineers use the deflection of light by materials, coupled with curved and patterned structures, such as lenses and gratings, for controlling electromagnetic radiation in optical and microwave systems. Currently, all optical systems are based on materials with a positive index of refraction. The introduction of materials with a negative index offers the potential for radically different designs in optical and microwave systems of the future.

Office of Scientific Research
Emerging Technologies

Additional information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTT, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (01-OSR-06)